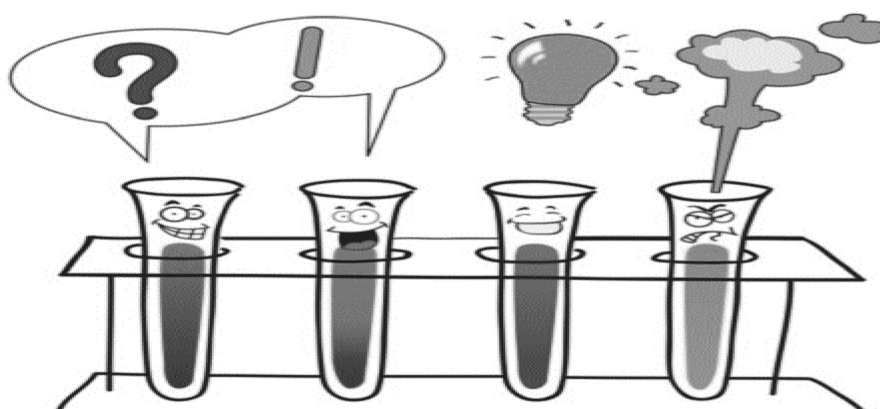
Chemistry

First Secondary
2024





Mr.Haitham Saeed

Chapter (1) Chemistry is the central science

Science: A systematic building that organizes knowledge in the form of facts principles, concepts, scientific theories and an organized way of search,

Chemistry: The science that studies the structure of matter, its properties, the changes that occur to it, the reaction of substances with each other and the suitable conditions for it

.

Biochemistry: The science that studies the chemical structure of different living organisms, and the reactions occurring within them.

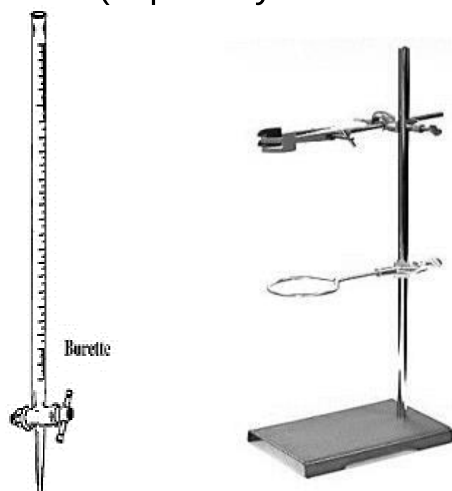
Physical chemistry: The science that studies the structure of substances, their properties and the particles forming them.

Measurement: Comparing an unknown quantity to another one of the same kind to know its size, degree or amount

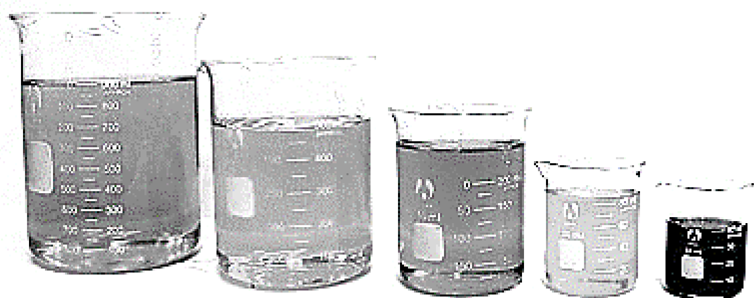
.

Measuring unit: The magnitude of a physical quantity which is approved by a law and used as a standard to measure the actual magnitude of this physical quantity

Burette: A long glass tube with 2 openings used to add liquids in very accurate experiments (especially in titration process).



Beaker: A glass container made of Pyrex glass used to hold and transport liquids, and measuring their volumes.



Glass cylinder: A cylinder made of either plastic or glass used to hold and transport solutions, and measuring the volumes of solutions and irregular solids.



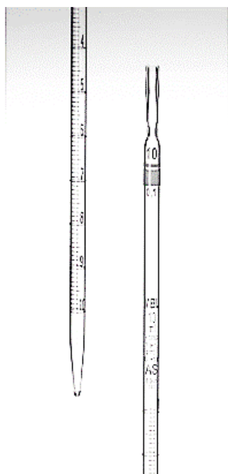
Round-bottom flask: A glass tool made usually of Pyrex glass and used in distillation and preparation processes



Volumetric flask: A glass tool made of Pyrex glass and used to prepare solutions of certain concentrations accurately.



Pipette: A long glass tool with both ends open used to transport liquids(especially dangerous ones) and measure their volume.





Power of hydrogen: The measurement of the concentration of positive hydrogen atoms in solutions to know if it's alkaline, acidic or neutral.

pH meter: A digital device used for calculating the pH of solution



pH-meter and
pH paper tape

Acidic solution	Neutral solution	Basic solution
The concentration of $H^+ > OH^-$	The concentration of $H^+ = OH^-$	The concentration of $H^+ < OH^-$
pH value < 7	pH value = 7	pH value > 7
pH<7	pH=7	pH>7

Nanotechnology: The technology of tiny objects, concerned with the Manipulation of matter on a nanoscale to create new, special and useful products.

Nanomaterials: Materials whose sizes range form 1 to 100 nm which have unique size-dependent properties.

Nanochemistry: One of Nano sciences which deals with the chemical applications of nanotechnology

Nanopollution: The pollution resulted from the substances and wastes produced by nanotechnology

Give Reason for each of the following:

1- The importance of chemistry
Because it studies the structure and properties of matter, changes that occur to it, reaction of substances with each other and the suitable conditions for it

2- Chemistry plays an important role in the physics
Because it helps physicists discover new accurate measurement methods. Moreover, physical chemistry (one of chemistry branches) studies the properties and structures of substances, and the particles forming them.

3- Chemistry plays an important role in biology
Because chemistry describes the chemical reactions occurring inside living organisms. Moreover, biochemistry (one of chemistry branches) studies the structure of different living organisms

4- Chemistry plays an important role in the medicine and pharmacy
Because chemistry finds out how enzymes and hormones work inside human Body, it also helps us in the manufacture of medicines.

5- Chemistry plays an important role in agriculture
Because it helps us choose suitable soil for certain crops, determine suitable fertilizers for them and helps us in the industry of pesticides

6- The rise of the idea of forming new measurement systems
Due to the industrial development after the industrial revolution in Europe, which made the old traditional measuring units insufficient for measurement

7- The occurrence of errors during measuring process (measuring process is not 100% accurate)

Due to errors in the used device, it use conditions, or error in human reading

8- The importance of measurement in chemistry
Because it's essential for protection, it helps us know the kind and concentration of the substances we need, and it also helps us evaluate situations and finding solutions for expected errors

9- The development of science and industry these days
Due to the right and accurate use of measurement principles

10- The importance of burettes in chemical laboratories
Because they are used in experiments that require high accuracy (used for adding small amounts of solutions during titration process)

11- The importance of beakers in chemical laboratories
Because they are used for holding and heating liquids, measuring their volumes and preparing chemical substances

12- The importance of glass cylinders
Because they are used for holding liquids, transporting them and measuring the volumes of solids and liquids.

13- The importance of conical flasks
Because they are used in titration process

14- The importance of round-bottom flasks
Because they are used in distillation and preparation processes

15- The importance of volumetric flasks
Because they are used for preparing solutions with certain concentrations accurately

16- The importance of pipettes
Because they are used for transporting certain volumes of solutions and measuring their volumes

17- The importance of pH (Power of hydrogen) measurement (or meter) in chemical and biochemical reactions.

Because it determines the concentration of positive hydrogen ions (H^+) in solutions , which helps us know if they are alkaline, acidic or neutral

18- The importance of Nanochemistry
Because it deals with the chemical applications of nanotechnology and the unique properties of Nanomaterials

19-The extraordinary properties of nanomaterials
Due to the increase of the ratio between the surface area and volume and the no. of atoms on the surface

20- size-dependant properties are called by this name
Because such properties change by the change of the size of substance

21- The importance of thin films.
Because they are used for plating roofs to protect them from corrosion and rusting, and packaging food industries to protect them from damage and pollution

22- The importance of Nanowires
Because they are used in the manufacture of electric circuits and Nano fibers (which are used in water filters industry)

23- The importance of carbon nanotubes
Because they are good conductors of heat and electricity, they can be used as biological sensors (due to their sensitivity to certain substances), and they also can be used in the manufacture of ropes in space-elevators (due to their solidity)

24- The importance of Bucky balls
Because they can be used for carrying medicine inside human body (which decreases side effects)

25- Nanotechnology plays an important role in medicine
Because it helps us diagnose diseases early, photograph organs and tissues, transport medicine right to the infected parts of the body, create tiny robots that remove blood clots from the arteries walls and transplant tiny devices to perform dialysis inside patients

26- Nanotechnology plays an important role in agriculture
Because it helps us find bacteria in food and improve insecticides and medicines for animals and plants, it also plays an important role in food preservation.

27- Nanotechnology improves energy resources
Because we can use it in the manufacture of sun batteries using Nano silicon(which are better at energy transformation and don't leak thermal energy), and hydrogen fuel cells with cheaper price and higher efficiency

28- Nanotechnology plays an important role in industry field
Because it can be used in the creation of nanoparticles which give glass autocleaning ability , and the manufacture of nanomaterials which purify ultraviolet rays (which are used in anti – sun creams and cosmetics) and stain-repellant clothes that can auto-clean themselves. It's also used for forming protective layers on electronic devices

29- Nanotechnology plays an important role in communication field
Because it is used for shrinking transistors sizes, used in the manufacture of Nano wireless devices, satellites, mobile phones and electronic chips with high capacities.

30- Some nanotechnology applications serve the environment
Because it can be used in the manufacture of Nano filters which work on solving nuclear wastes problem, purifying air and water, and removing the dangerous elements from industrial wastes

31- Nanosubstances have adverse health effects
Because their tiny sizes make them able to attach to air, so they can penetrate the cells of human, animals and plants.

32- Nanotechnology has adverse environmental effects
Because the tiny wastes resulted from nanotechnology can attach to air and penetrate both animal and plant cells. It also affects climate, water, air and soil

33- Nanotechnology has negative social effects
Because it may worsen the problems of unfair distribution of wealth and technology, social and economic inequality.

Questions

1- Choose the correct answer

1- the measuring tool which is used to measure the volumes of the liquids accurately is …….

A- flask B- beaker C- pipete D- graduated cylinder

2- The glass tool used for distillation and preparation processes is:-

A- round-bottom flask B- Graduated cylinder
C- Pipette D- Burette

3- chemical engineers work at new factories including these which produce allthe following,except the………..

A- metals B- cosmetics C- tyres D- seeds

4- what is the science which is interested in the separation process and the detection of the components of the substance qualitatively quantitatively?

A- organic chemistry B- biochemistry C- Analytical chemistry D- environmental chemistry

5-………. Studies the chemical structure of living organisms

A- Biochemistry B- Physical chemistry
C- Electrochemistry D- Analytical Chemistry

6- The small volumes of liquids can be measured by:-

A- Graduated beaker B- Volumetric flask
C- Graduated cylinder D- Test tube

7- …….. are from one-dimensional nanomaterials

A- Carbon nanotubes B- Thin films C- Bucky balls D- Nanoshells

8- One nanometer equals…. Meter

A- 10^{-7} B- 10^{-9} C- 10^{-6} D- 10^{-4}

9- nanotechnology is important because………

A- It needs special devices to deal with it
B- Its value ranges from 1 to 100 nm
C- It has special properties
D- Nanomaterials industry require special properties

10- The small volumes of liquids can be measured by……

A- Graduated beaker B- Volumetric flask
C- Graduated cylinder D- Test tube

11- Which one of the following numbers is the greatest

A- 10^{-3} B- 10^{-2} C- 10^{-7} D- 10^{-9}

12- When dividing a cube into smaller cubes

A- The surface area decreases while the volume increases
B- The surface area increases while the volume decreases
C- The surface area doesn't change while the volume increases
D- Both surface area and volume don't change

13- The behavior of nanoparticles are linked with their tiny sizes because:-

A- The ratio between surface area and volume is very great if compared to bigger sizes
B- The ratio between surface area and volume is smaller if compared to smaller sizes
C- The no. of atoms on the particles surface is much greater
D- A and C

14-A student wants to perform an experiment to measure the time of dissolving 2 g of magnesium completely in 100 mL of hydrochloric acid, what are the required tools forthis experiment ?

A-Stopwatch, graduated cylinder, sensitive balance.
B-Graduated cylinder, thermometer, sensitive balance.
C-Stopwatch, sensitive balance.
D-Stopwatch, graduated cylinder.

15-The following dimensions are of a nano ceramic particle 320 nm , 135 nm ,40nm This particle is a substance.

A-one-dimensional nano B-two-dimensional nano
C-three-dimensional nano D-multi-walled

Chapter (2) Quantitative chemistry

Chemical equation: The representation of chemical reaction using chemical symbols,. formulas of reactants and products, and the conditions of it

* Here are some examples of the cations and the anions forming ionic compounds :

Cations (Metal ions)

Li^+	Lithium ion
Na^+	Sodium ion
K^+	Potassium ion
Ag^+	Silver ion
Mg^{2+}	Magnesium ion
Ca^{2+}	Calcium ion
Zn^{2+}	Zinc ion
Ba^{2+}	Barium ion
Al^{3+}	Aluminum ion
Fe^{2+}	Iron (II) [ferrous] ion
Fe^{3+}	Iron (III) [ferric] ion
Cu^+	Copper (I) [cuprous] ion
Cu^{2+}	Copper (II) [cupric] ion

Positive atomic group

NH_4^+	Ammonium group

Anions (Nonmetal ions)

F^-	Fluoride	O^{2-}	Oxide
Cl^-	Chloride	S^{2-}	Sulphide
Br^-	Bromide	N^{3-}	Nitride
I^-	Iodide	P^{3-}	Phosphide

Negative atomic groups

OH^-	Hydroxide	ClO_4^-	Perchlorate
NO_3^-	Nitrate	SO_4^{2-}	Sulphate
CH_3COO^-	Acetate	CO_3^{2-}	Carbonate
HCO_3^-	Bicarbonate	CrO_4^{2-}	Chromate
HSO_4^-	Bisulphate	$Cr_2O_7^{2-}$	Dichromate
NO_2^-	Nitrite	SO_3^{2-}	Sulphite
MnO_4^-	Permanganate	PO_4^{3-}	Phosphate

* **Before studying the ionic equations, it is necessary to know :**

1 The most famous acids and bases which ionize (dissociate) completely in water :

The most famous acids which ionize completely in water	The most famous bases which ionize completely in water
• Hydrochloric acid. $HCl_{(g)} \xrightarrow{water} H^+_{(aq)} + Cl^-_{(aq)}$	• Potassium hydroxide. $KOH_{(s)} \xrightarrow{water} K^+_{(aq)} + OH^-_{(aq)}$
• Nitric acid. $HNO_{3(\ell)} \xrightarrow{water} H^+_{(aq)} + NO^-_{3(aq)}$	• Sodium hydroxide. $NaOH_{(s)} \xrightarrow{water} Na^+_{(aq)} + OH^-_{(aq)}$
• Sulphuric acid. $H_2SO_{4(\ell)} \xrightarrow{water} 2H^+_{(aq)} + SO^{2-}_{4(aq)}$	• Barium hydroxide. $Ba(OH)_{2(s)} \xrightarrow{water} Ba^{2+}_{(aq)} + 2OH^-_{(aq)}$

2 The most famous salts that dissolve in water and those which do not dissolve in water :

The most famous salts which dissolve in water	The most famous salts which do not dissolve in water
• **All nitrate salts** dissolve in water. $KNO_{3(s)} \xrightarrow{water} K^+_{(aq)} + NO^-_{3(aq)}$	• **All phosphate salts** do not dissolve in water, **except:** $Na_3PO_{4(s)}$, $K_3PO_{4(s)}$, $(NH_4)_3PO_{4(s)}$
• **All bicarbonate salts** dissolve in water. $NaHCO_{3(s)} \xrightarrow{water} Na^+_{(aq)} + HCO^-_{3(aq)}$	• **All carbonate salts** do not dissolve in water, **except:** $Na_2CO_{3(s)}$, $K_2CO_{3(s)}$, $(NH_4)_2CO_{3(s)}$
• **All sulphate salts** dissolve in water, **except:** $Ag_2SO_{4(s)}$, $CaSO_{4(s)}$, $BaSO_{4(s)}$, $PbSO_{4(s)}$	• **All sulphite salts** do not dissolve in water, **except:** $Na_2SO_{3(s)}$, $K_2SO_{3(s)}$, $(NH_4)_2SO_{3(s)}$
• **All chloride salts** dissolve in water, **except:** $CuCl_{2(s)}$, $PbCl_{2(s)}$, $AgCl_{(s)}$	• **All solid hydroxides** do not dissolve in water, **except:** $KOH_{(s)}$, $NaOH_{(s)}$, $NH_4OH_{(s)}$, $Ba(OH)_{2(s)}$ (The degree of solubility of $Ca(OH)_2$ is low)

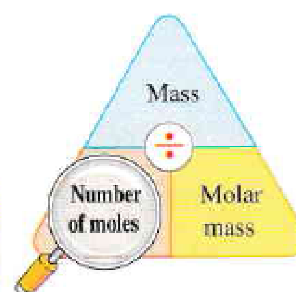
Avogadro's number: The no. of ions, molecules and atoms in one mole of matter(6.02×10^{23} matter unit/mole)

Mole: The mass of atoms, molecules, or formula units of matter in grams which contain Avogadro's number of them

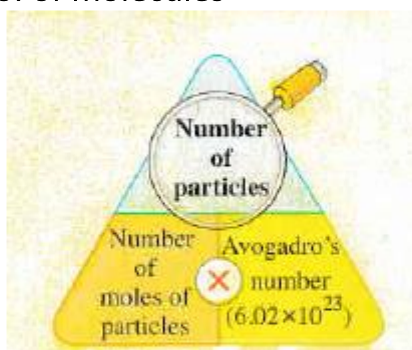
Calculation of the number of moles

• **We can calculate the number of moles by using the following relation :**

$$\text{Number of moles (mol)} = \frac{\text{Mass of substance (g)}}{\text{Molar mass (mass of one mole) (g/mol)}}$$



Avogadro's law: Equal volumes of gases in the same conditions of pressure and temperature have the same no. of molecules



Gay-Lussac's law: The volumes of reactant and product gases have certain volumes expressed in whole number

Empirical formula: The formula that describe the simplest ratio between the atoms of the elements forming the compound molecules

Molecular formula: The symbolic formula of the molecule of a compound which describes the kind and the actual no. of the atoms forming that molecule

$$\text{Mass percentage of an element in a compound} = \frac{\text{Mass of the element in a mole of the compound}}{\text{Molar mass of the compound}} \times 100\%$$

- Experimental results which are obtained practically, **from the relation :**

$$\text{Mass percentage of an element in a sample} = \frac{\text{Mass of the element in the sample}}{\text{Mass of the sample}} \times 100\%$$

The sum of the percentages of the elements composing the compound must equal 100%

Practical yield: The amount of substances we get practically from the reaction

Theoretical yield: The amount of substances we expect to get form the reaction

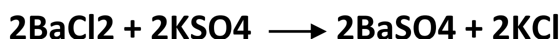
The percentage yield (the percentage of practical yield)

$$100 \times \frac{\text{Practical yield}}{\text{Theoretical yield}}$$

Example:-

39.4 gm of solid barium sulphate $BaSO_4$ precipitated when 40 gm of barium chloride solution $BaCl_2$ reacted with potassium sulphate. Calculate the percentage yield of barium sulphate

Solution



$2BaCl_2 + 2KSO_4 \longrightarrow 2BaSO_4 + 2KCl$

Mole of **$BaCl_2$** = 137 + 35.5 + 35.5 = 208 gm

Mole of **$BaSO_4$** = 137 + 32 + 16+16+16+16 = 233 gm

The no. of **$BaCl_2$** moles = mass of substance / molar mass = 40/208 = 0.19 mol

2 moles of **$BaCl_2$** ⟶ 2 moles of $BaSO_4$
0.19 mole of **$BaCl_2$** ⟶ 0.19 mol of $BaSO_4$
The mass of **$BaSO_4$** = 0.19 x molar mass = 0.19 x 233 = 44.8 gm
The practical yield = 39.4 gm
The theoretical yield = 44.8 gm
The percentage yield = the practical yield / the theoretical yield x 100
= 39.4/44.8 x 100 = 87.95%

Example:-
Acetic acid of weight 60 gm contains 40% carbon, 6.67% hydrogen and oxygen53.33%(C=12, O=16, H=1). Calculate its molecular formula

Solution:-
Oxygen : Hydrogen : Carbon

$\frac{53.33}{16}$	$\frac{6.67}{1}$	$\frac{40}{12}$
$\frac{3.33}{1}$	$\frac{6.67}{2}$	$\frac{3.33}{3}$

The empirical formula: CH_2O
The molar mass of Acetic acid = 12 + 1+1+16 = 30 gm
The no. of units = 60/30 = 2 units
The molecular formula = CH_2O x 2 = $C_2H_4O_2$

Give Reason for :

1- The volume of 26 gm Acetylene gas (C2H2) is equal to the volume of 2g of hydrogen gas in (STP) conditions
Because the mole of Acetylene molecule equals 26 gm, and the mole of hydrogen molecule equals 2g. By applying Avogadro's law, we'll find that the volumes of both gases are equal in (STP) conditions (because they contain the same no. of moles)

2- The molar mass of phosphorus differs according to its physical state
Because in gaseous state, phosphorus molecule consists of 4 atoms, while in solid state, It consists of 1 atom. So, the molar mass of gaseous phosphorus is different from that of solid phosphorus

3- Litre of oxygen gas has the same no. of molecules in a litre of chlorine gas in STP conditions
Because according to Avogadro's law, equal volumes of gases in STP conditions have the same no. of molecules

4- the no. of molecules in 9 gm of water H_2O is equal to that in 39 gm of Aromatic Benzene (C_2H_2)
Because the mass of one mole of water = 9 gm, whereas the mass of one mole of Aromatic Benzene = 39 gm, so they have the same no. of molecules (Avogadro's number) because they have the same no. of moles

5- Chemical equations should be balanced
In order to get the required amounts of products

6- Gas should be in STP conditions in order to calculate its volume using its molar mass
Because in STP conditions, one mole of any gas occupies volume of 22.4 litres

7- The molar mass of sulphur in solid state is different from that in gas state
Because a molecule of gaseous sulphur contains 8 atoms of sulphur, while that Of solid sulphur contains only 1 atom. So, they have different molar masses

8- The actual (practical) yield is always less than the theoretical yield
Because the reactants may be impure, side reactions may occur, the products may be volatile and spread in the air, or they can stick to the glass containers Walls.

Questions

1- Choose the correct answer

1-In the equation : $XP_4O_6 + H_2O \longrightarrow YH_3PO_3$
What is the value of the coefficient (Y) when (X) = 2 ? ....

A- 2 B- 4 C- 6 D- No correct answer

2-What is the summation of the coefficients in this equation after balancing ?



A- 9 B- 8 C- 7 D- 6

3-What are the ions which are not written in the net ionic equation of the reaction of potassium hydroxide solution with hydrochloric acid ?............

A- K^+, H^+ B- H^+ , OH^- C- K^+ , Cl^- D-H^+,Cl^-

4-A mole of potassium dichromate contains……..

A-1 mol of K B- 4 mol of Cr C- 7 mol of O D- 1 mol of Cr

5-What is the number of moles of nitrogen gas which react with 18 g of magnesium to form magnesium nitride compound ?.........[N=14 ,Mg =24]

A-0.25 mol B-0.5 mol C- 1mol D-2 mol

6-What is the number of the molecules in a sample of arnmonia NH3 its mass equals 43.5 g ?............... molecules. [N=14 , H=1]

A-2.62×10^{25} B-2.36×10^{23} C-1.54×10^{24} D- 8.63×10^{-16}

7- When 50 gm of $CaCO_3$ decomposes thermally, ……..gm of CaO is formed (Ca = 40, C=12, O=16)

A- 28 B- 16 C- 76 D- 35

8- The volume of hydrogen required to form 11.2 L of water is……….

A- 22.4 L B- 11.2 L C- 68.2 L D- 44.8 L

9- the abbrivation(g)is written down the right of the chemical formula of the compound in its…….

A- solid state B- liquid state C- gaseous state D- aqueous state

10- A mole of potassium dichromate contains…….

A- 1 mol of K B- 4 mol of Cr C- 7 mol of O D- 1 mol of Cr

11- The mass of 44.8L of ammonia gas (NH3) in STP conditions is ………gm. (N=14, H=1)

A- 0.5 B-2 C- 17 D- 34

12- If an amount of sodium has 3.01x10^{23} atoms, so its mass is ……..gm

A- 11.5 B- 0.5 C- 23 D-46

13- The chemical equation should be balanced according to ....

A- Avogadro's law B- Gay-Lussac's law
C- law of mass conservation D- Law of energy conservation

14- 0.5 mole of carbon dioxide gas (CO_2) weighs….. gm (C=12, O=16)

A- 22 B- 44 C-66 D-88

15- When 64 gm of oxygen reacts with hydrogen, ….. litres of water vapour (H_2O) are formed

A- 11.2 B- 22.4 C- 44.8 D- 89.6

16- The no. of moles in 36g of water equals…………
(H=1,O=16)

A- 1 B-2 C- 3 D- 4

17- The no. of molecules in 128g of sulphur dioxide (SO_2) equals… (S=32, O=16)

A- 2 B- 6.02x10^{23} C- 3.01x10^{23} D- 12.04x10^{23}

18- The no. of sodium ions resulted from the dissolution of 40g of sodium hydroxide (NaOH) equals…..(Na=23,O=16,H=1)

A- 2 B- 6.02x10^{23} C- 3.01x10^{23} D- 12.04x10^{23}

19- The volume of 4g of hydrogen in STP conditions equals …

A- 11.2 B- 22.4 C- 44.8 D- 89.6

20- The volumes of reactant gases are inversely proportional to those of products according to……….

A- Avogadro's law B- Gay-Lussac's law
C- law of mass conservation D- Law of energy conservation

21- The empirical formula of $C_4H_8O_2$ is………….

A- C_2H_4O B- C_4H_2O C- CH_4O_2 D- $C_2H_8O_2$

22- The no. of empirical formulas in $C_2H_2O_4$ is …..

A-1 B-2 C- 3 D-4

23- If the empirical formula of a compound is CH2 and its molar mass if 56g, its molecular formula is…..

A- C_2H_4 B- C_4H_8 C- C_3H_6 D- C_5H_{10}

24- If the molecular formula of Vitamin C is C6H8O6, its empirical formula is….

A- $C_3H_4O_3$ B- $C_3H_4O_6$ C- $C_3H_8O_3$ D- C_3H_6O

25- The empirical formula CH_2O describes……

A- CH_3 COOH B- $C_6H_{12}O_6$ C- HCHO D- All the previous answers

26- The hydrocarbon compound formed from the reaction of 0.1 mol. of carbon atoms with 0.4 mol. of hydrogen atoms is……

A- CH_4 B- C_2H_4 C-C_4H_8 D- C_3H_8

2- Solve the following problems

1- Find the no. of sodium ions resulted from the dissolution of 117g of sodium chloride ($NaCl$) in water (Na=23,Cl=35.5)

2- 26.5g of sodium carbonate (Na_2CO_3) reacted with an abundant amount of hydrochloric acid in STP conditions (Na=23,C=12, O=16) find:-

a- The no. of water molecules.

b- The volume of carbon dioxide gas.

3- Calculate the no. of moles in 144gm. of carbon (C=12).

4- Calculate the mass of 2.4 moles of calcium carbonate (CaCO_3).
(Ca=40, C=12, O=16).

5- Calculate the volume of 56g of nitrogen gas in STP conditions (N=14).

6- 23g of sodium (Na) reacted with water(H_2O) forming sodium hydroxide (NaOH) and hydrogen gas (Na=23, O=16, H=1), Find:-

a- The no. of sodium ions resulted from the reaction.

b- The volume of evolving hydrogen gas.

7- Calculate the molar mass of gaseous phosphorus in STP conditions, and the no. of atoms in one mole of it.

8- Find the molecular formula of a compound containing 85.7% carbon and14.3% hydrogen whose molar mass is 42g

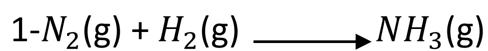
9- 130g of silver chloride (AgCl) precipitated when a mole of sodium chloride(NaCl) reacted with silver nitrates ($AgNO_3$), calculate the percentage yield

(percentage of actual yield) (Ag=108, N=14, Cl= 35.5, Na= 23,O=16)

10- Calculate the weight percent of iron in $FeCO_3$ (Fe=56, C=12, O=16)

11- Calculate the weight percent of the elements forming Glucose sugar $C_6H_{12}O_6$(C=12, H=1, O=16)

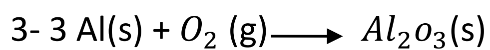
3- Balance the following equations



1-N_2(g) + H_2(g) $\longrightarrow$ NH_3(g)



2- Cu$(NO_3)_2$(s) $\longrightarrow$ CuO(s) + NO_2(g) +O_2 (g)



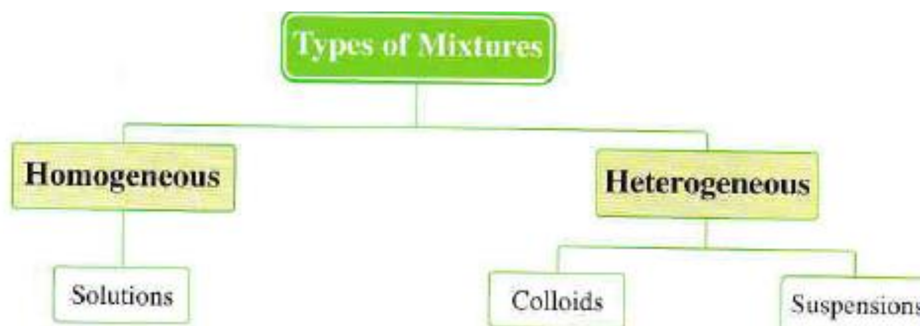
3- 3 Al(s) + O_2 (g) $\longrightarrow$ Al_2o_3(s)

4- Represent the following reactions by balanced ionic equations

1- The reaction of sodium chloride with silver nitrates forming a white ppt. of silver chloride and sodium nitrates.

2- The reaction of Nitric acid with potassium hydroxide solution forming potassium nitrate solution and water.

Chapter (3) Solutions – acids and bases





The table shows the difference between these types :

Solutions	Colloids	Suspensions
Their components can't be distinguished by the naked eye or the electronic microscope	Their components can be distinguished by the electronic microscope only	Their components can be distinguished by the naked eye
Examples		**Examples**
• Table salt in water. • Table sugar in water. • Cobalt (II) chloride in water.	• Aerosols. • Hair gel. • Mayonnaise emulsion. • Blood. • Milk.	• Table salt in kerosene. • Table sugar in kerosene. • Cobalt (II) chloride in kerosene. • Oil in water.
Cobalt (II) chloride $CoCl_2$ solution	*Milk*	Oil Water *Water-oil suspension*

True solution: A homogenous mixture of two or more substances

★ **The following table shows some examples of these different types :**

Types of solutions	Solute	Solvent	Examples
A Gaseous solutions	Gas	Gas	• Atmospheric air. • Natural gas.
B Liquid solutions	Gas	Liquid	• Soft drinks. • Oxygen dissolved in water.
	Liquid	Liquid	• Alcohol in water. • Ethylene glycol (antifreeze) in water.
	Solid	Liquid	• Sugar in water. • Salt in water.
C Solid solutions	Gas	Solid	Hydrogen gas on palladium or platinum
	Liquid	Solid	Liquid mercury dissolved in solid silver (silver amalgam) $Ag_{(s)}/Hg_{(l)}$
	Solid	Solid	Alloys such as nickel-chrome alloy

Electronegativity: The ability of atom to attract electrons

Polar bond: A type of covalent bond between two atoms in which electrons are shared unequally (the greater atom carries a negative charge)

Polar molecule: A Molecule which has a bond carrying molecular positive charge and another one carrying molecular negative charge

Electrolytes: Substances whose solutions can conduct electric current via the movement of free ions

Non electrolytes: Substances whose solutions cannot conduct electricity because of the absence of free ion

Solubility: The mass of solute dissolving in 100g of solvent at certain temperature

Dissolution process: The process in which the solute molecules disassociate into negative ions, positive ions, or separated polar molecules and then get surrounded by the molecules of solvent

Unsaturated solutions: Solutions that allow additional amounts of solute to dissolve in them at certain temperature

Saturated solutions: Solutions that doesn't allow the dissolution of any additional amounts of solute without change in temperature

Super saturated solutions: Solutions that allow the dissolution of additional amounts of solute when heating.

Endothermic solutions: Solutions which absorb energy (heat) when they are formed

Exothermic solutions: Solutions which give away energy (heat) when they are formed

A Mass percentage (m/m)

It is the percentage of the mass of solute in 100 g of solution

B Volume percentage (V/V)

It is the percentage of the volume of solute in 100 mL of solution

law

$$\text{Mass percentage (m/m)} = \frac{\text{Solute mass (g)}}{\text{Solution mass (g)}} \times 100\%$$

Solution mass = Solute mass + Solvent mass

$$\text{Volume percentage (V/V)} = \frac{\text{Solute volume (mL)}}{\text{Solution volume (mL)}} \times 100\%$$

Solution volume = Solute volume + Solvent volume

Molarity: The no. of moles of solute dissolved in one litre of solvent

Molality (m): The no. of moles of solute dissolved in one kilogram of solvent

2 Molarity (M)

It is the number of moles of solute dissolved in one litre of solution

3 Molality (m)

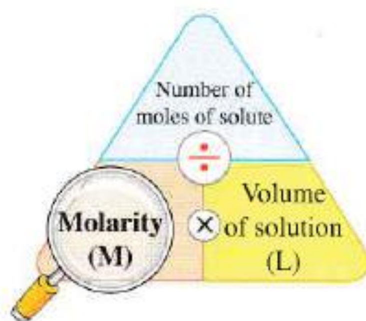
It is the number of moles of solute in one kilogram of solvent

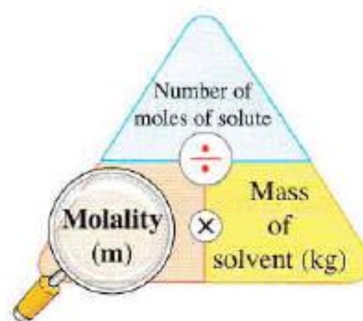
law

$$\text{Molarity (M)} = \frac{\text{Number of moles of solute (mol)}}{\text{Volume of solution (L)}}$$

$$\text{Molality (m)} = \frac{\text{Number of solute moles (mol)}}{\text{Mass of solvent (kg)}}$$

$$\text{Number of moles of the solute (mol)} = \frac{\text{Mass of the solute (g)}}{\text{Molar mass of the solute (g/mol)}}$$





Measuring unit

The unit of molarity is (mol/L) or Molar (M)

The unit of molality is (mol/kg) or molal (m)

Vapour pressure: The pressure exerted by vapour when it becomes in state of equilibrium with the liquid inside a closed container at constant temperature and pressure

Boiling point: The temperature at which the vapour pressure of solution becomes equal to the atomic pressure

★ Comparison between the solution and the pure solvent "in terms of : Colligative properties"

Colligative properties	Solution		Its pure solvent
Vapour pressure	Vapour pressure of solution	$<$	Vapour pressure of pure solvent
Boiling point	Boiling point of solution	$>$	Boiling point of pure solvent
Freezing point	Freezing point of solution	$<$	Freezing point of pure solvent

Colloids: Non homogenous mixtures whose particles don't precipitate and they are hard to be separated using filter paper

* **Classification of colloidal systems according to the state :**

Dispersed phase	Dispersion medium	Examples
Gas	Liquid	Some types of whipped cream – whipped egg.
	Solid	Sweet made of sugar (cotton candy).
Liquid	Gas	Aerosols – fog.
	Liquid	Mayonnaise – emulsion of oil and vinegar.
	Solid	Hair gel.
Solid	Gas	Dust in air.
	Liquid	Pigments – blood – milk - starch in hot water.

* **Comparison between solution, colloid and suspension :**

Points of comparison	Solution	Colloid	Suspension
Homogeneity	Homogeneous mixture	Heterogeneous mixture	Heterogeneous mixture
Size of particles	< 1 nm	1 : 1000 nm	> 1000 nm
Vision	Can't be seen by the naked eye or distinguished by the microscope	Can't be seen by the naked eye, but it is distinguished by the microscope only	Can be seen by the naked eye
Scattering of light beam	Doesn't scatter the light but allows to pass it	Scatters the light	Scatters the light
Precipitation	No precipitate	No precipitate	Precipitate
Filtration (separation) of particles	Can't be separated	Can't be separated	Can be separated

Arrhenius acid: The substance which disassociate in water producing one or more positive hydrogen ions (H^+)

Arrhenius base: The substance which disassociate in water producing one or more negative hydroxide ions (OH^-)

Bronsted-Lowry acid: The substance that loses protons during chemical reaction(proton donor)

Bronsted-Lowry base: The substance that has the ability to gain protons (proton acceptor)

Conjugate acid: The substance formed when a base gains proton

Conjugate base: The substance formed when an acid loses proton

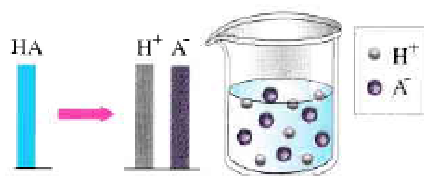
Lewis acid: The substance which gains one or more electrons

Lewis base: The substance which loses one or more electrons

Theory	Acid	Base
Arrhenius	The substance that dissolves in water, giving one or more positive hydrogen ions H^+ $HCl_{(g)} \xrightarrow{water} H^+_{(aq)} + Cl^-_{(aq)}$	The substance that dissolves in water, giving one or more hydroxide ions OH^- $NaOH_{(s)} \xrightarrow{water} Na^+_{(aq)} + OH^-_{(aq)}$
Brönsted-Lowry	The substance that donates a proton H^+	The substance that accepts a proton H^+
	$HCl_{(g)} + H_2O_{(\ell)} \longrightarrow H_3O^+_{(aq)} + Cl^-_{(aq)}$ Acid, Base, Conjugate acid, Conjugate base	
Lewis	The substance that accepts a lone pair of electrons or more	The substance that donates a lone pair of electrons or more
	$H^+_{(aq)} + :F^-_{(aq)} \longrightarrow HF_{(aq)}$ Acid, Base	

Strong acids

Which are completely ionized in water



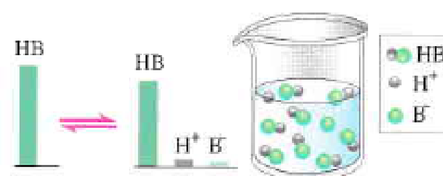

$HA \longrightarrow H^+ + A^-$

Strong acid

- Their aqueous solutions are good conductors of electricity.
- They are strong electrolytes.
- As all their molecules ionize in water.

Weak acids

Which are incompletely ionized in water




$HB \rightleftharpoons H^+ + B^-$

Weak acid

- Their aqueous solutions are bad conductors of electricity.
- They are weak electrolytes.
- As a small part of their molecules ionizes in water.

Examples

Strong acids:

- Perchloric acid $HClO_4$
- Hydroiodic acid HI
- Hydrochloric acid HCl
- Hydrobromic acid HBr
- Sulphuric acid H_2SO_4
- Nitric acid HNO_3

Weak acids:

- Carbonic acid H_2CO_3
- Phosphoric acid H_3PO_4
- Acetic acid (vinegar) CH_3COOH
- Formic acid.
- Citric acid.
- Oxalic acid.
- Lactic acid.

* **Acids are classified according to their sources (origins) into :**

Organic acids

- Acids that have an organic origin (plant or animal).

  i.e. They are extracted from the organs of living organisms.
- All of them are weak acids.

Mineral acids

- Acids that have no organic origin.

  i.e. They usually have a nonmetallic elements in their structures like chlorine, sulphur, nitrogen and phosphorus.
- Some of them are strong acids and others are weak.

Examples

Organic acids:

- Lactic acid (milk products).
- Acetic acid (vinegar).
- Citric acid (from citrus plants).
- Oxalic acid.
- Formic acid (from ants).

Mineral acids:

- Carbonic acid.
- Hydrochloric acid.
- Phosphoric acid.
- Perchloric acid.
- Nitric acid.
- Sulphuric acid.

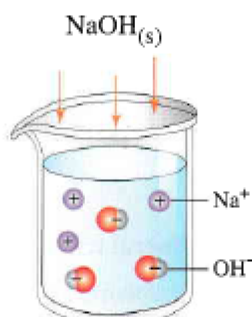
* **Acids are classified according to their basicity into :**

Monobasic acids (Monoprotic)	Dibasic acids (Diprotic)	Tribasic acids (Triprotic)
Acids where each molecule gives one proton H^+, when it dissolves in water	Acids where each molecule gives one or two protons H^+, when it dissolves in water	Acids where each molecule gives one, two or three protons H^+, when it dissolves in water
Examples		**Examples**
• **Organic monobasic acids :** - Formic acid $HCOOH$ - Acetic acid CH_3COOH	• **Organic dibasic acids :** Oxalic acid $COOH - COOH$	• **Organic tribasic acids :** Citric acid $H_2C - COOH$, $HO - C - COOH$, $H_2C - COOH$
• **Mineral monobasic acids :** - Hydrochloric acid HCl - Nitric acid HNO_3	• **Mineral dibasic acids :** - Carbonic acid H_2CO_3 - Sulphuric acid H_2SO_4	• **Mineral tribasic acids :** Phosphoric acid H_3PO_4
HNO_3 *Monobasic acid*	H_2SO_4 *Dibasic acid*	H_3PO_4 *Tribasic acid*

* **Bases are classified according to their degree of ionization (dissociation) into :**

Strong bases

Which are completely ionized in water



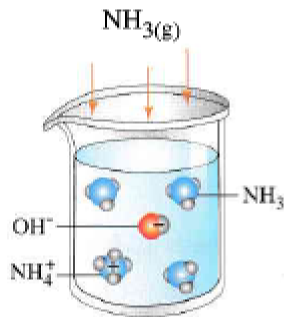
Strong base NaOH

1 mol of it dissociates in water yielding 1 mol of OH^- ions

- Their solutions are good conductors of electricity.
- They are strong electrolytes.
- As all their molecules dissociate in water into ions.

Weak bases

Which are incompletely ionized in water



Weak base NH_3

1 mol of it ionizes partially in water yielding very small number of OH^- ions

- Their solutions are bad conductors of electricity.
- They are weak electrolytes.
- As a small part of their molecules ionizes in water into ions.

Examples

Strong bases:

- Potassium hydroxide KOH
- Sodium hydroxide $NaOH$
- Barium hydroxide $Ba(OH)_2$

Weak bases:

- Ammonium hydroxide NH_4OH

Indicators: weak acids and bases whose colours change by the change of solution

* **The following table shows examples of some indicators and their colours in different media :**

Indicator	Colour in acidic medium	Colour in neutral medium	Colour in basic medium
Methyl orange	Red	Orange	Yellow
Phenolphthalein	Colourless	Colourless	Pink
Litmus	Red	Purple	Blue
Bromothymol blue	Yellow	Pale green	Blue

pH: A method used for determining the acidity or basicity of a solution in numerical values ranging from 0 to 14

Give Reason for :

1- The importance of solutions
Because they are essential for the biological processes within living organisms and important for the occurrence of some chemical reactions

2- Water molecules are polar
Because the Electronegativity difference between oxygen and hydrogen atoms forming them is great

3- Sodium chloride solution is considered as strong electrolyte
Because sodium chloride molecules completely disassociate into ions when they dissolve in water, which give the solution the ability to conduct electricity

4- Acetic acid is a weak electrolyte
Because some of its molecules disassociate into ions when they dissolve in water, which makes them weak conductors of electricity

5- Ethyl alcohol is considered as electrolyte
Because it doesn't conduct electricity (as its molecules do not disassociate into ions)

6- The boiling point of sodium chloride solution (NaCl) is smaller than that of sodium carbonate (Na_2CO_3) although their masses are equal
Because the no. of ions produced from sodium chloride solution is less than that of sodium carbonate, and as we know, solute particles decrease the no. of water molecules escaping from the surface of solution. Therefore, water molecules need more energy which increases the boiling point

7- Adding nonvolatile solutes to solvents decrease the freezing point of the solution
Because they increase the attraction forces between the solute particles and the solvent molecules, which prevents the solvent from turning into solid state

8- The dissolution of sugar in water forms a solution, while the dissolution of dry milk in water forms a colloid
Because sugar particles spread in all parts of water regularly forming homogenous mixture and they cannot be distinguished by naked eyes, whereas dry milk particles spread irregularly in water molecules and this non homogenous mixture has the properties of both solutions and suspensions (but its components cannot be separated by using filter papers)

9- There aren't any free protons in the aqueous solutions of acids
because they bond with water molecules forming hydronium ions $(H_3O)^+$

10- Ammonia is considered as a base although it doesn't have hydroxide groups in its structure
Because according to Lewis theory, ammonia accepts protons from water molecules forming hydronium ions.

11- Nitric acid is a strong acid
Because its molecules completely disassociate in water into ions, which gives its aqueous solutions the ability to conduct electricity efficiently

12- Acetic acid is a weak acid
Because some of its molecules disassociate in water into ions, which makes its aqueous solutions weak conductors of electricity.

13- Ethyl alcohol is nonelectrolyte
Because its molecules doesn't disassociate in water into ions and cannot conduct electricity.

14- Some acids such as carbonic acid have two types of salts
Because their molecules structure contain two hydrogen atoms (dibasic acids)

15- pH of ammonium chloride solution is less than 7
Because it has an acidic effect, as its formed from an anion of strong acid(chloride negative ion) and a cation of weak base (ammonium positive ion)

16- pH of sodium carbonate solution is more than 7
Because it has a basic effect, as it's formed from an anion of weak acid and a cation of strong base

17- pH of acetic acid equals 7
Because the strengths of the acid anion and base cation are equal

Questions

1- Choose the correct answer

1-Which of the following is a mixture ?..........

A-$NaCl_{(l)}$ B-$NaCl_{(aq)}$ C-H_2O(v) D-H_2O(s)

2- Water vapour in air is a gaseous solution of kind…..

A- gas in gas B- gas in liquid
C- liquid in gas D- solid in gas

3- The measure of the angle between the two bonds of water molecule equals……

A- 140 B-140.5 C- 108.5 D- 104.5

4- …… is from strong electrolytes

A- Benzene B- H2O C- HCl (g) D- HCl (aq)

5- The measuring unit of molality (m) is ……

A- mol/kg B- mol/L C- g/L D- g/eq.L

6- Phosphoric acid H_3PO_4 is ……. Acid

A- Monobasic B- Dibasic C- Tribasic D-Multibasic

7- The pH of an acidic solution is…..

A- 7 B- 5.5 C- 8.5 D-14

8- When ammonia reacts with hydrochloric acid, ammonium ion NH_4^+ is…

A- Conjugate acid B- acid C- Base D- Conjugate base

9-…… is a strong acid

A- Acetic acid B- Carbonic acid
C- Nitric acid D- Citric acid

10- The colour of phenolphthalein changes to fuchsia in a solution of …. pH

A- 2 B-4 C-6 D-9

11-What is the mass of the solution of glucose $C_6H_{12}O_6$ whose concentration is 10%and it contains 1 mol of the solute ?........ [C=12 , O= 16 , H=1]

A- 1 Kg B- 1.8Kg C-200g D-900g

12-What is the concentration of sodium hydroxide solution whose volume is 2.5 L andcontains 0.4 g of NaOH ? ....

A-l6 % B-1.6 % C-0.16% D-0.016 %

13-The mass of sodium carbonate which is required to prepare 500 mL of 0.5 M solution equals…………. [Na=23 , C=12 , O=16]

A-10000g B-106g C-40g D-26.5g

14-200 mL of a solution contain 0.04 mol of $(NH_4)_2Ni(SO4)_2.6H_2O$, What is the concentration of ammonium ions NH_4^+, in it ?.............................

A-0.0004 M B-0.008 M C-0.2 M D-0.4 M

15-According to the reaction **:** $\mathbf{4FeCl_{2(aq)}+3O_2 \longrightarrow 2Fe_2O_3(s) +4Cl_2}$
What is the volume of 0.76 M solution of FeCl2 which reacts completely with 6.36×10^{21} molecules of oxygen ? ....

A-$5.26X10^3$ ml B-10.7ml C- 10.4 ml D-18.5ml

16-5 mol/L sulphuric acid has been diluted from 1 L to 10 L,what is the molar concentration of the dilute acid ?

A-0.1 M B-0.5M C-1M D-5M

17-Which of the following salts has higher effect on the depression of the vapour pressure of water when 1 mol of it is dissolved in one liter of water ? ......

A-KCl B-$MgCl_2$ C-$C_6H_{12}O_6$ D-KBr

18-An amount of oil is dissolved in a known mass of pure benzene, so if the vapour pressure of benzene is 750 mm Hg .What is the vapour pressure of the solution ?.........

A-760 mm Hg B-750 mm Hg C-731.5 mm Hg D-25 mm Hg

19-Boiling point of one mole of water changes by 0.5℃ on dissolving one mole of the ions of the solutepotassium phosphate in it, what is the boiling point of the molal solution of………….

A-100. 5℃ B-99. 5℃ C-98℃ D-102℃

20-Which of the following solutions its freezing point approaches that of the aqueous solution ol $C_{12}H_{22}O_{11}$, whose concentration = 0.3 m ?.........

A-0.075 m $AlCl_3$ B- 0.15 m $CuCl_2$ C-0.3 m NaCl D-0.6 m $C_6H_{12}O_6$

21-What is the mass of the precipitate which is produced from the reaction of 95 g of magnesium with excess phosphoric acid?............[Mg=24,P=31,O=16]

A-24g B-48g C-240g D-349.3g

22-The conjugate acid of the base $HAsO_4^{2-}$, is ……………

A-H_3O^+ B-AsO_4^{3-} C-H_3AsO_4 D-$H_2AsO_4^-$

23-All the following are Bronsted Lowry acids, except………

A- CH_3COO^- B-HCO_3^- C-HSO_3^- D-NH_4^+

24- Which of the following acidic substances is polyprotic ? ....

A-CH_3COOH B-NH_4^+ C- H_3PO_4 D- HCOOH

25-which of the following is a monohydric base (contains one hydroxyl group) ?

A-NH_4OH B-HOH C-CH_3COOH D-Mg(oH)$_2$

2- Solve the following problems

1- Calculate the percent concentration of sucrose in a solution containing 10g of sucrose and 240g of water.

2- If we add 50 ml of water to 25 ml of ethanol (ethyl alcohol) calculate the percent concentration of ethanol in the solution.

3- Find the molar concentration of a sodium hydroxide solution of volume 200 ml containing 20g of sodium hydroxide (NaOH)

(Na=23, O=16, H=1)

4- if 53g of sodium carbonate (Na_2CO_3) dissolved in 400g of water, calculate the molality of the solution (Na=23, O=16, C=12, H=1)

Model Exam 1

Choose the correct answer for the questions 1 : 10 (10 marks)

1 Which of the following choices is incorrect regarding the importance of measurement ? ....

Choices	Importance	Example
(a)	Monitoring	Determination of aspirin dose for a child.
(b)	Health care	Monitoring glucose in the blood of a diabetic patient.
(c)	Information	The proportions of the components of a milk package.
(d)	Management	Adding a basic substance to highly acidic soil.

2 What is the number of molecules of oxygen in 466.6 mL sample (at STP) ? ....

(a) 1.25×10^{22} molecules. (b) 1.34×10^{22} molecules.
(c) 3×10^{22} molecules. (d) 3×10^{26} molecules.

3 The following compounds are similar in all the following, except ....


• $CH_3CH_2CH_2COOH$ • $OHCCH_2CH_2CH_2OH$ • $CH_3CHCHCH_2SH$

[C = 12 , H = 1 , O = 16 , S = 32]

(a) The mass percentage of carbon and hydrogen in each of them.
(b) Their molar masses.
(c) Each of them contains 3 elements.
(d) Number of atoms of the elements.

4 One mole of ethanol C_2H_6O is oxidized by potassium permanganate solution which is acidified with sulphuric acid, forming ethanoic acid $C_2H_4O_2$, if the percentage of the actual yield is 60%, so what is the mass of ethanoic acid which can be actually collected from the oxidation of 2.3 g of ethanol ? .... [C = 12 , H = 1 , O = 16]

(a) 1.32 g (b) 1.38 g
(c) 1.8 g (d) 3 g

5 On dissolving 7.1 g of Na_2SO_4 (its molar mass = 142 g/mol) in water, 0.5 L of .... solution is produced.

(a) 2.5×10^{-2} M (b) 1×10^{-1} M (c) 1×10 M (d) 1×10^{2} M

6 A wall is painted by an old paint, a part of it is mistakenly sprayed with a new paint, if the two paints can not dissolve in the same solvent, which of the following solvents can remove the new paint without damaging the old paint ? ....

Solvent	(a)	(b)	(c)	(d)
Old paint	Does not dissolve in it	Does not dissolve in it	Dissolves in it	Dissolves in it
New paint	Does not dissolve in it	Dissolves in it	Does not dissolve in it	Dissolves in it

7 Which of the following aqueous solutions of the nonvolatile substance (X) has higher boiling point ? A solution contains ....

(a) 1 mol of (X) in 2 kg of water.
(b) 2 mol of (X) in 1 kg of water.
(c) 1.5 mol of (X) in 1.5 kg of water.
(d) 0.5 mol of (X) in 1 kg of water.

8 The opposite figure shows a whipped cream which is a colloid in which .... is dispersed in ....



(a) liquid / liquid.
(b) gas / liquid.
(c) solid / liquid.
(d) liquid / solid.

9 In the reaction which is represented by the following equation :



$$HCO_3^- + H_2O \rightleftharpoons H_2CO_3 + OH^-$$

The two Brönsted - Lowry acids in each of reaction directions are ....

(a) H_2O , OH^-
(b) HCO_3^- , OH^-
(c) H_2O , H_2CO_3
(d) HCO_3^- , H_2CO_3

10 Aniline $C_6H_5NH_2$ is a weak base which ionizes in water, according to the equation :



$$C_6H_5NH_{2(aq)} + H_2O_{(l)} \rightleftharpoons C_6H_5NH^+_{3(aq)} + OH^-_{(aq)}$$

What is (are) the substance(s) which exist(s) in the aqueous solution of aniline ? ....

(a) OH^- only.
(b) $C_6H_5NH_2$ only.
(c) $C_6H_5NH_3^+$, OH^- only.
(d) $C_6H_5NH_2$, H_2O , $C_6H_5NH_3^+$, OH^-

11 Illustrate how to protect iron from rusting by using the nanotechnology.

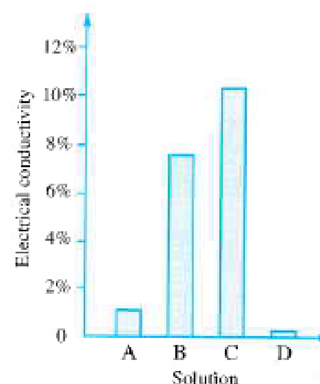
....

.... 1 mark

12 The opposite graphical figure shows the percentage of the electrical conductivity of 4 different solutions, which are (with no particular order) :

- Glucose.
- Sodium chloride.
- Acetic acid.
- Sodium carbonate.

Choose for each solution the letter which refers to it in the figure.



(A) : ....

(B) : ....

(C) : ....

(D) : ....

...... 2 marks

13 When a cube of sugar was added to an aqueous solution of the same sugar, it was observed that it precipitated in the bottom of the container and did not dissolve (apparently).. **What is the scientific explanation of this observation ?**

....

...... 1 mark

14 **Calculate the number of moles of** chloride ions in an aqueous solution contains 811.75 g of iron (III) chloride.

[Fe = 55.85 , Cl = 35.5]

....

....

....

....

....

....

....

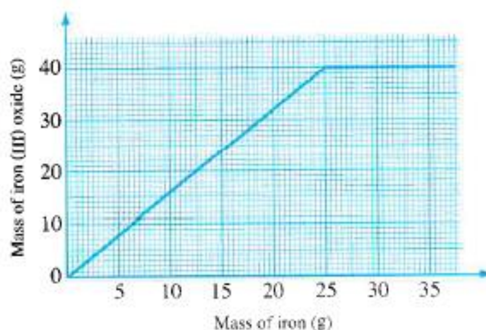
....

....

....

...... 2 marks

15 The opposite graph represents the masses of iron (III) oxide produced from the combination of iron with oxygen gas at suitable conditions :



(1) Write the balanced symbolic chemical equation which represent this reaction.

....

....

(2) What is the limiting reactant of this reaction ? Explain.

....

....

....

....

....

.... 2 marks

16 Calculate the number of moles of the atoms of the elements found in 44.8 L of ammonia gas (at STP).

....

....

....

....

....

.... 1 mark

17 Write the balanced symbolic equation which represents the reaction of an acid with a base to form a salt formed of Mg^{2+} cations and Cl^{-} anions.

....

....

.... 1 mark

Model exam 2

Choose the correct answer for the questions 1 : 10 — 10 marks

1. Which of the following measuring relations is incorrect ? ....
   - a) 1 microliter = 1×10^{-6} L
   - b) 1 gram = 1×10^{-6} kg
   - c) 1 liter = 10^3 mL
   - d) 10^2 centigram = 1 g

2. What is the mass percentage of hydrogen in chlorous acid $HClO_2$? .... [H = 1 , Cl = 35.5 , O = 16]
   - a) 1.92%
   - b) 25%
   - c) 23.4%
   - d) 1.46%

3. What is the number of nitrogen atoms in 240 g of ammonium nitrate ? .... atoms. [N = 14 , H = 1 , O = 16]
   - a) 2×10^{23}
   - b) 6.02×10^{23}
   - c) 1.81×10^{24}
   - d) 36.12×10^{23}

4. What is the total number of moles of H^+ which are found in 2.5 L phosphoric acid its concentration is 0.7 M ? ....
   - a) 0.233 mol
   - b) 2.1 mol
   - c) 5.25 mol
   - d) 3 mol

5. Which of the following solutions which have equal molal concentrations has higher boiling point ? ....
   - a) HI solution.
   - b) $(NH_4)_3PO_4$ solution.
   - c) NH_4Cl solution.
   - d) NaI solution.

6. Which of the following colloids is formed from dispersion of liquid in solid ? ....
   - a) Hair gel, cheese and butter.
   - b) Milk, hair gel and blood.
   - c) Aerosol, hair gel and mayonnaise.
   - d) Mayonnaise, hair gel and cheese.

7. 35.5 mL aqueous solution contain 22.5 g of sucrose (its molar mass = 342 g/mol) .. What is the molar concentration of this solution ? ....
   - a) 0.0657 M
   - b) 1.85×10^{-3} M
   - c) 1.85 M
   - d) 0.104 M

8 10 g of hydrogen gas react with excess of oxygen gas according to the equation :



$$2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O_{(v)}$$

What is the reacted volume of oxygen gas (at STP) and the mass of the produced water vapour in this reaction ? .... [H = 1 , O = 16]

Choices	Reacted volume of O_2	Mass of H_2O
(a)	2.5 L	5 g
(b)	5 L	5 g
(c)	56 L	90 g
(d)	80 L	120 g

9 Each of the following acids when dissolves in water, it can yield more than one proton, except ....

(a) oxalic acid. (b) sulphuric acid. (c) carbonic acid. (d) acetic acid.

10 What does happen when a small crystal of the solute substance is put in its supersaturated solution ? ....

(a) The crystal dissolves in the solution only.
(b) The solution becomes saturated only.
(c) The molecules of the solute will be collected around the crystal only.
(d) (b) and (c) together.

---

11 "Carbon is found in the form of graphite and diamond"..
Mention three other forms in which carbon can be found.

....

....

1 mark

12 Calculate the molar mass of calcium phosphate compound. [Ca = 40 , P = 31 , O = 16]

....

....

1 mark

13 Complete the following equation, and rewrite it in the form of an ionic equation :



$$Fe(NO_3)_{2(aq)} + (NH_4)_2CO_{3(aq)} \longrightarrow \text{..............} + \text{..............}$$

....

....

2 marks

14 What is the type of the aqueous solution of sodium nitrate salt (acidic, basic or neutral) ? Explain.

....

....

2 marks

15 In this reaction : $NH_{3(g)} + H_2O_{(l)} \rightleftharpoons NH^+_{4(aq)} + OH^-_{(aq)}$

What does each of the following represent in the light of Lewis concept of acids and bases :

(1) Ammonia gas.

....

(2) Water.

....

1 mark

16 Sulphuric acid is added to barium hydroxide until the reaction is completed, write the balanced symbolic equation which represents this reaction, with illustrating the physical state of barium hydroxide only in this reaction, then explain which is larger in number :

The ions which are present in the beginning of the reaction or the ions which are present at the end of the reaction ?

....

....

....

....

....

2 marks

17 Calculate the percentage of the actual yield of zinc sulphate, if its calculated (theoretical) mass = 1.358 g and its actual mass = 1.146 g

....

....

....

....

....

....

1 mark

Model exam 3

Choose the correct answer for the questions 1 : 10



1 The conjugate base of ethanol C_2H_5OH is ....

a) CH_3CH_2OH b) $C_2H_5OH_2$ c) $CH_3CH_2O^-$ d) CH_3OCH_3

2 Avogadro's number is ....

a) the number of the atoms in one gram of the element.

b) the number of the molecules in one gram of the compound.

c) the volume which is occupied by one mole of a gas at standard conditions.

d) the number of the molecules in the gram molecular mass of the substance.

3 The volume percentage of oxygen in atmospheric air is 21%

what is the number of moles of oxygen in 1 L of air (at STP) ? ....

a) 0.186 mol b) 0.0094 mol c) 0.21 mol d) 2.1 mol

4 Ammonia gas reacts with oxygen gas according to the unbalanced equation :



$$NH_{3(g)} + O_{2(g)} \longrightarrow NO_{(g)} + H_2O_{(v)}$$

What is the number of oxygen moles required to react completely with 6.8 g of ammonia gas ? .... [N = 14 , H = 1]

a) 0.5 mol b) 1 mol c) 2.5 mol d) 5 mol

5 Which of the following acids has higher pH value ? ....

a) 0.1 M HCl b) 0.2 m HCl

c) 0.1 M CH_3COOH d) 0.15 m HNO_3

6 10 nm is equivalent to ....

a) 10^{-8} m b) 10^{-7} m c) 10^{-9} m d) 10^{-10} m

7 By comparing the freezing point of 1 m sodium nitrate solution with that of 1 m calcium nitrate solution, the freezing point of ....

a) both solutions are equal as they are equally concentrated.

b) calcium nitrate solution is lower as it contains the higher number of ions.

c) sodium nitrate solution is lower as it contains the higher number of ions.

d) calcium nitrate solution is lower because its molar mass is higher.

8 Which of the following choices represents the ointments which are used in the treatment of bacterial infections ? ....

Choices	Gel	Suspension
a	✓	✓
b	✓	✗
c	✗	✓
d	✗	✗

9 Which of the following solutions has higher ability to conduct electricity ? ....

a) 0.1 M HCl
b) 1 M LiOH
c) 2 M H_3PO_4
d) 2 M C_2H_5OH

10 If the chemical formula of calcium pyrophosphate is $Ca_2P_2O_7$, so the chemical formula of iron (III) pyrophosphate is ....

a) $Fe_2(P_2O_7)_3$
b) FeP_2O_4
c) $Fe(P_2O_7)_3$
d) $Fe_4(P_2O_7)_3$

11 The opposite figure represents the movement of the ions with and against the gravity of earth through a root hair of a plant.

Suggest the name(s) of the science(s) that is (are) likely to be integrated with chemistry in this kind of studies.

Soil grains

Root hair

....

....

.... 1 mark

12 The two opposite figures show two beakers which contain two different aqueous solutions, write the net ionic equation which represents the reaction between them.

NH_4^+ I^-

Ag^+ NO_3^-

....

....

.... 1 mark

13 Calculate the mass of potassium in a sample of potassium dichromate $K_2Cr_2O_7$ its mass = 27.8 g

[K = 39 , Cr = 52 , O = 16]

....

....

....

....

....

2 marks

14 An organic compound with empirical formula CHCl, and its molar mass = 291 g/mol, what is the number of moles of carbon atoms in one mole of this compound ?

[C = 12 , H = 1 , Cl = 35.5]

....

....

....

....

....

....

2 marks

15 Calculate the molar concentration of 250 mL of a solution which contains 3.01×10^{23} molecules of sodium hydroxide.

....

....

....

....

....

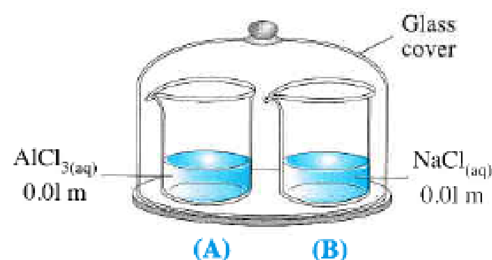
....

....

....

2 marks

16 The opposite figure represents two beakers (A) and (B), they both contain the same volume of two different solutions which have the same molal concentration, **in which beaker** the level of the surface of the solution decreases more than the other ? **Explain.**



....

....

....

....

.... 1 mark

17 A litmus paper wetted with water is approached to the mouth of a test tube contains a mixture of ammonium chloride and sodium hydroxide solutions..

What is the change in the colour of the litmus paper ? Explain.

....

....

....

.... 1 mark

Model exam 4

Choose the correct answer for the questions 1 : 10



1. In bucky ball, what is the number of carbon atoms that each carbon atom is attached to ? ....

   (a) 1 (b) 2 (c) 3 (d) 4

2. Each of the following is a solution, except ....

   (a) iron filings with sulphur powder.
   (b) hydrogen chloride gas in water.
   (c) iodine in benzene.
   (d) silver in mercury.

3. Two closed vessels contain chlorine gas at the same conditions of temperature and pressure, so if the first vessel whose volume = 1.3 L contains 6.7 mol of gas, what is the number of moles in the second vessel whose volume = 2.33 L ? ....

   (a) 0.452 mol
   (b) 3.74 mol
   (c) 12 mol
   (d) 20.3 mol

4. Which of the following aqueous solutions that have the same molal concentration has lower freezing point ? ....

   (a) CH_3OH
   (b) NaF
   (c) $MnSO_4$
   (d) $(NH_4)_2SO_4$

5. In which of these choices $H_2PO_4^-$ acts as an acid ? ....

   (a) $H_3PO_4 + H_2O \rightleftharpoons H_3O^+ + H_2PO_4^-$
   (b) $H_2PO_4^- + H_2O \rightleftharpoons H_3O^+ + HPO_4^{2-}$
   (c) $H_2PO_4^- + OH^- \rightleftharpoons H_3PO_4 + O^{2-}$
   (d) The ion can't act as an acid in any chemical reaction.

6. All the following are colloids, except ....

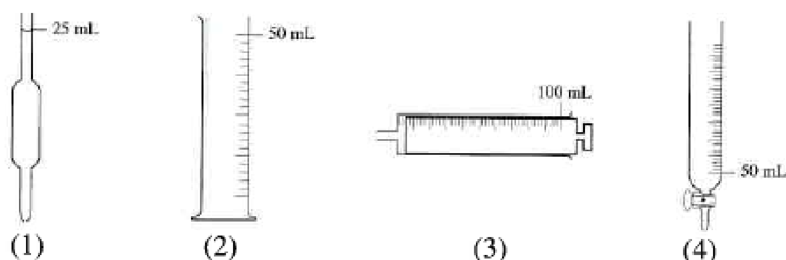
   (a) air in whipped egg white.
   (b) air in cotton candy.
   (c) ground maize powder in water.
   (d) oxygen in atmospheric air.

7 Molal solution contains 1 mol of the solute in ....

(knowing that pure water density = 1 kg/L)

(a) 1000 L of the solvent.
(b) 1000 g of the solution.
(c) 1 L of water.
(d) 22.4 L of the solution.

8 Here are four different measuring tools :



Which of the following choices represents the proper use for the measuring tool ? ....

Choices	Measuring tool	Used in
(a)	(1)	Transferring 20 mL of an alkali to carry out a titration.
(b)	(2)	Collecting 75 mL of the gas produced from a thermal decomposition reaction.
(c)	(3)	Adding 1 mL of an acid to calcium carbonate.
(d)	(4)	Adding 15.6 mL of an acid to carry out a titration.

9 On dissolving NH_4ClO_4 acid in water, the formed solution is ....

(a) acidic.
(b) neutral.
(c) basic.
(d) amphoteric.

10 What does it mean that nitric acid is a strong acid ? ....

(a) It dissolves in water and H^+ concentration in the solution equals OH^- concentration.
(b) It does not ionize in water on dissolving in it.
(c) It ionizes completely in water into H^+ , NO_3^- ions.
(d) It is neutralized by a strong base only.

11 Calculate the mass of oxygen in 0.52 g of sodium bicarbonate.

[Na = 23 , H = 1 , C = 12 , O = 16]

....

....

....

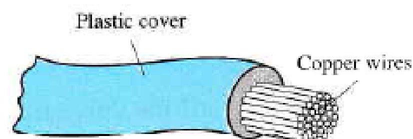
....

....

....

1 mark

12 The opposite figure represents a section in a flexible copper cable, it easily bends with the bends of the plastic pipes inside walls and ceilings, **is it useful to** replace copper which is used in the manufacture of cable wires with any of the following ? **Explain your answer.**



(1) Copper nanowires.

....

....

....

(2) Single-walled carbon nanotubes.

....

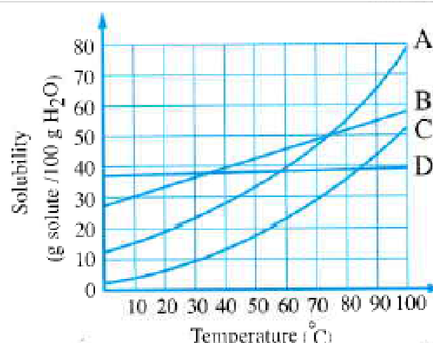
....

....

.... 2 marks

---

13 The opposite graph shows the solubility curve of four different substances A , B , C and D, **which of these substances its solubility is :**



(1) As high as possible at 10°C

....

(2) As low as possible at 90°C

....

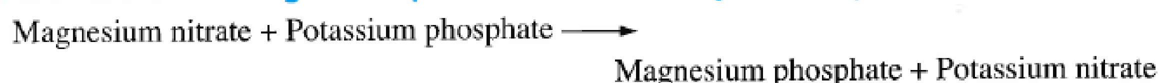
.... 1 mark

14 **Compare between** hydrogen chloride gas **and** glucose **by filling in the spaces in the following table :**

Points of comparison	Hydrogen chloride gas	Glucose
(1) Solubility in water	....	....
(2) Ionization in water	....	....

.... 2 marks

15 **Rewrite the following word equation as a balanced symbolic equation :**



Magnesium nitrate + Potassium phosphate ⟶ Magnesium phosphate + Potassium nitrate

....

....

.... 1 mark

16 **Choose, with explanation,** one or more of the following substances that can be present in a test tube which contains phosphoric acid :









....

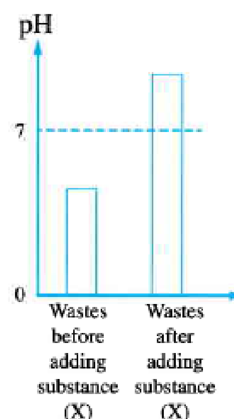
....

....

....

...... 2 marks

17 The opposite graphical figure represents pH values of the wastes of a factory before and after adding substance (X), **what is the type of substance (X) ? Explain.**



....

....

....

....

....

...... 1 mark

Model exam 5

Choose the correct answer for the questions 1 : 10 — 10 marks

1. $H_2O_{(s)}$ is classified as ....
   (a) an ionic compound.
   (b) a covalent compound.
   (c) a homogeneous mixture.
   (d) a heterogeneous mixture.

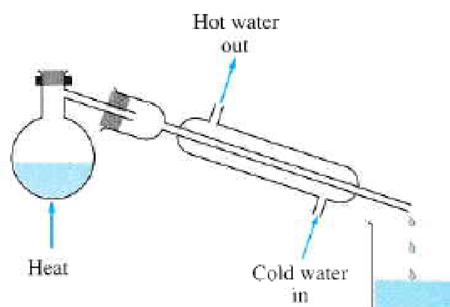
2. What is the percentage of the actual yield of the reaction of 2.5 mol of $Fe(NO_3)_3$ with 3.6 mol of Na_2CO_3 to form 6.3 mol of $NaNO_3$ according to the reaction :
   $2Fe(NO_3)_3 + 3Na_2CO_3 \longrightarrow Fe_2(CO_3)_3 + 6NaNO_3$? ....
   (a) 50%
   (b) 84%
   (c) 87.5%
   (d) 100%

3. Which of the following is an Arrhenius acid ? ....
   (a) HBr
   (b) NaOH
   (c) NaBr
   (d) NH_3

4. Propane C_3H_8 burns according to the reaction :
   $$C_3H_{8(g)} + 5O_{2(g)} \longrightarrow 3CO_{2(g)} + 4H_2O_{(v)}$$
   Which of the following represents the correct ratio between oxygen and propane gases as reactants ? ....
   (a) $\frac{5\ g\ O_2}{1\ g\ C_3H_8}$
   (b) $\frac{5\ mol\ O_2}{1\ mol\ C_3H_8}$
   (c) $\frac{10\ g\ O_2}{11\ g\ C_3H_8}$
   (d) $\frac{10\ mol\ O_2}{11\ mol\ C_3H_8}$

5. Which of the following compounds dissolves in water forming a solution which has a relative ability to conduct electricity ? ....
   (a) C_2H_5OH
   (b) $C_6H_{12}O_6$
   (c) $C_{12}H_{22}O_{11}$
   (d) CH_3COOH

6. The apparatus which is illustrated in the opposite figure is used in the simple distillation of table salt solution, where is each of the salt and water collected at the end of the experiment ? ....



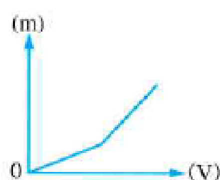
Choices	Salt	Water
(a)	Volumetric flask	Glass beaker
(b)	Conical flask	Glass beaker
(c)	Glass beaker	Round-bottom flask
(d)	Round-bottom flask	Glass beaker

7 On adding excess of potassium iodide KI solution gradually to mercury (II) chloride solution $HgCl_2$, these two reactions occur :

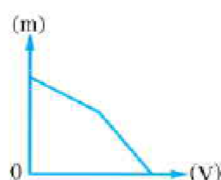

• $HgCl_{2(aq)} + 2KI_{(aq)} \longrightarrow HgI_{2(s)} + 2KCl_{(aq)}$


• $HgI_{2(s)} + 2KI_{(aq)} \longrightarrow K_2HgI_{4(aq)}$

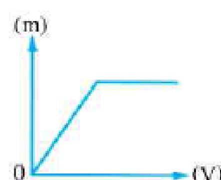
Which of the following graphical figures represents the relation between the mass of the formed precipitate (m) and the added volume of KI solution (V) ? ....



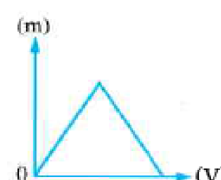
(a)



(b)



(c)

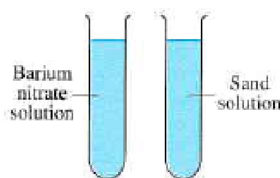


(d)

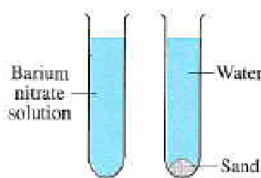
8 A mole of sodium sulphite is similar to a mole of sodium sulphate in all of the following, except ....

(a) number of moles of O atoms.
(b) number of moles of Na atoms.
(c) number of moles of S atoms.
(d) number of moles of ions in the aqueous solution.

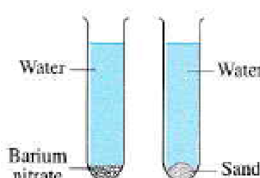
9 Which of the following choices represents what is expected when each of barium nitrate and sand is stirred, individually, in water ? ....



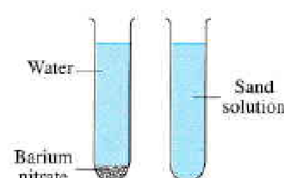
(a)



(b)



(c)



(d)

10 Sulphuric acid is a strong dibasic acid..
Which of the following statements is correct ? ....

(a) 1 mol of sulphuric acid ionizes in water yielding 2 mol of ions.
(b) Sulphuric acid forms only acidic salts.
(c) Sulphuric acid forms two types of salts.
(d) Sulphuric acid reacts with divalent metals only.

11 **Calculate the gram mass of** a sample of aluminum contains half Avogadro's number of atoms. **[Al = 27]**

....

....

....

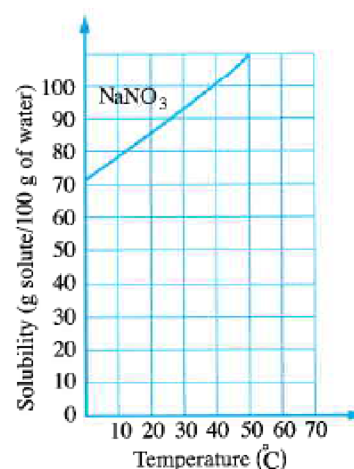
....

....

....

.... / 1 mark

12 **The opposite graph represents** the solubility curve of sodium nitrate salt $NaNO_3$, **illustrate by the chemical calculations the molality of** a saturated solution of $NaNO_3$ (at 40°C). **[Na = 23 , N = 14 , O = 16]**



....

....

....

....

....

....

....

....

....

....

.... / 2 marks

13 **Illustrate with explanation** the type of a mixture formed of particles with diameter 1.9×10^{-8} m

....

....

....

....

.... / 1 mark

14 In the light of the interest of the scientists in reducing the consumption of the aviation fuel, there are attempts being made to replace the copper conductors with plastic conductors known as polyaniline ..

What is the substance which is added to polyaniline to render it a better electric conductor than copper ?

....

.... 1 mark

15 Two solutions of glucose, the concentration of the first is 2 M, and that of the second is 1 M

Which of these two solutions has higher boiling point ? Explain.

....

....

....

....

.... 1 mark

16 A chemical compound its empirical formula is CH_2O and each 0.0835 mol of it contains 1 g of hydrogen..

Deduce the molecular formula of this compound.

....

....

....

....

....

....

....

....

....

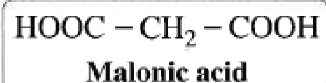
....

....

....

.... 2 marks

17 Malonic acid is used in synthesis of vitamins B_1, B_2 :



(1) Calculate the mass percentage of oxygen in malonic acid.

[C = 12, H = 1, O = 16]

....

....

....

....

....

....

(2) Mention a similarity and a difference between malonic acid and citric acid.

....

....

....

.... 2 marks